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$9^\circ\ 58'\ 30''$ East, of distances of the sun's and moon's limbs were observed, corresponding to a watch regulated to mean time. Barometer $29^{\text{in}}{\cdot}9$ Thermometer 15° Réaumur.

	Mean of Times.	Mean of Distances.
	h m s	h m s
	4 39 54 P.M.	79 29 36·5
		15 36·5
		15 47·5
Appt. Dist. D		80 1 0·5

"From the *Nautical Almanac* we obtain sun's mean R.A. $4^h\ 28^m\ 29^s{\cdot}49$; sun's true R.A., $4^h\ 25^m\ 36^s{\cdot}623$; equat. of time, $+ 2^m\ 52^s{\cdot}9$; sun's Decl., $+21^\circ\ 41'\ 14''{\cdot}3$; sun's semid., $15'\ 48''{\cdot}5 - 1'$ contract; moon's R.A., $10^h\ 4^m\ 28^s{\cdot}45$; moon's Decl., $+15^\circ\ 2'\ 35''{\cdot}8$; moon's semid. $15'\ 24''{\cdot}5$ + augmen. $12''$; moon's eq. hor. par. $= 56'\ 24''{\cdot}8$, Red. for spheroid $= 7''{\cdot}2$; geocentric latitude $\varphi' = 53^\circ\ 22'\ 10''$, $t = 70^\circ\ 41'\ 43''{\cdot}5$, $t' = 14^\circ\ 1'\ 15''$.

"Thence we find for the sun $\varepsilon = 39^\circ\ 55'\ 41''$, $Z = 61^\circ\ 19'\ 29'' = \varrho - \pi$ by second approx. $= 1'\ 44''{\cdot}3$; $d\,\alpha = 1'\ 12''{\cdot}05$; $P = 68^\circ\ 17'\ 26''$.

"For the moon $\varepsilon' = 13^\circ\ 1'\ 40''$; $Z' = 39^\circ\ 53'\ 8''{\cdot}5$; $\pi' - \varrho' = 35'\ 45''{\cdot}5$; $d\,\alpha' = 8'\ 19''{\cdot}48$; $P' = 75^\circ\ 32'\ 14''{\cdot}3$; $A\ 84^\circ\ 50'\ 9''{\cdot}0$; $\alpha = 84^\circ\ 43'\ 1''{\cdot}57$, in time $5^h\ 38^m\ 52^s{\cdot}105$, which, being added to the sun's true R.A. $4^h\ 25^m\ 36^s{\cdot}623$, gives for the moon's true R.A. $10^h\ 4^m\ 28^s{\cdot}728$, whence the longitude will be found $9^\circ\ 58'{\cdot}24$."

On the Connexion between the Sun's Motion and the Variations of Terrestrial Magnetism. By Professor Secchi.

(*Extract of a Letter to Capt. Manners, R.N.*)

"Colonel Sabine, as you know, has published and discussed with admirable sagacity an immense mass of observations of the phenomena of terrestrial magnetism, and in the last volume of the the Toronto Observations has shown that in the tropical regions the opposition of oscillation of the needle follows so strictly the change of the sun's declination, that the change of the former can be traced to the very day of the equinox. This consequence, although apparent from the curves of the tropical countries, was not so clearly perceived in the countries more distant from the tropics. But it was evident, that if the law was true, it would become visible everywhere, provided a suitable mode of analysis should be applied. I thought, therefore, that the want of its being apparent there, was due to the kind of graphical analysis used until now, which consists in referring the monthly curves, either to the absolute mean of the year, or to the mean of the month itself. I undertook, therefore, to refer the monthly curves to the mean annual hourly curve of the year. The reason of doing so is this: the effect of diurnal variation at any hour (as far as it depends on the sun) is the complex effect of its hour-angle and of declination. The mean annual hourly curve, as deduced from the observations of the whole year, is a residual function independent of the declination which acts in opposite directions in

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the two halves of it. Therefore, if from any mean monthly curve we subtract the mean hourly curve of the year, the residual quantity so obtained will be a function of the declination of the sun. I have, therefore, executed these operations (which are done very easily, using the tables and plates of Colonel Sabine exhibiting the monthly ranges of the needle variation in declination), and the result has been a good deal more satisfactory than I ever expected. The results for the four colonial observatories are contained in the figures here enclosed, and a simple glance at them shows that for opposite declinations of the sun their curvatures are directed in opposite parts, and that their change can be traced to the very day of the equinox. Even some irregularities which may puzzle in the figures of Colonel Sabine for the tropical regions, have their explanation here. Thus, for instance, at St. Helena the curve of June has a descending flexure which is wanting in that of January. Now the differential curves of the declination show that this branch disappears from the interference of a similar branch, but opposed in the two months of opposite declination. We can generally state, that the mean curve of the declinometer at any country of the globe results from the interference of the two curves, one depending only on the diurnal period, and the other on the declination of the sun: the first is constant in its direction through all the year, and the second changes according to the position of the sun relatively to the equator. The inspection of these curves shows a general feature of the solar periodical influence: this is, that the maximum and minimum differ in time very nearly six hours; and their phases depend on the passage of the sun through the magnetic meridian of the place, so that an acceleration occurs in those places where the north declination is greater. For the southern hemisphere the complete antagonism of forces requires a contrary law.

"These facts seem to strengthen the opinion that the solar action is a direct one on the needle. To verify this hypothesis, I have subjected it to calculation in this way: I consider the needle, according to the Anpérian theory, as an element of galvanic current circulating during the day in a circle, which is the parallel that it describes during the diurnal rotation of the earth; and applying to this hypothesis the formula given by Savary for the action of a magnet on an element of current circulating in a circle, neglecting the terms of the order higher than the first and those depending on the parallax of the sun, I obtain the three following expressions for the components of the solar action, relatively to the horizon as a fundamental plane of co-ordinates:

$$X_0 = \frac{k\,l\,R}{r^2} \sin\delta \sin\omega,$$

$$Y_0 = \frac{k\,l\,R}{r^2} \cos(L+\delta)\cos\omega,$$

$$Z_0 = \frac{k\,l\,R}{r^2} \sin(L+\delta)\cos\omega,$$

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and the resultant,

$$S = \frac{k\,l\,R}{r^2}\sqrt{1-\cos^2\delta\,\sin^2\omega}.$$

Where X_0 is the component directed perpendicularly to the meridian along the line east-west; Y_0 that directed along the line south-north, and Z_0 is vertical; k is a constant co-efficient dependent on the intensity of solar force; l, the length and magnetical moment of the needle; r, the distance of the sun from the centre of the circle; R, the radius of the parallel described by the needle; L, the latitude of the place; δ, the declination of the sun; ω, its hour-angle. If now we call Δ the deviation of the needle from its mean position, and P the resultant of those forces which act in that plane in which the needle is only moveable, we will have

$$\Delta = \frac{P}{\tau}\sin h + 2\,\frac{P^2}{\tau^2}\sin 2h + \;.\;.\;.\;.$$

where τ is the component of the force of terrestrial magnetism or gravity, which acts in the plane of P, and h the angle between P and the mean position of the needle; and also here we will retain only the first term.

"To find the different laws of motion for the three well-known magnetical instruments, let us suppose first a place where the declination of the needle $= 0$: in this case the magnetic and astronomical meridians coincide; and for the declinometer we shall have $P = S\cos b$, b being the altitude of the sun, and calling a its azimuth, it will be

$$\Delta = \frac{k\,l\,R}{\tau\,r^2}\sqrt{1-\cos^2\delta\,\sin^2\omega}\,\cos b\,\sin a,$$

and since

$$\cos x = \cos b\,\sin a = \sin\omega\,\cos\delta,$$

we have

$$\Delta = \frac{k\,l\,R}{2\,\tau\,r^2}\sin 2x,$$

calling x the angle made by the sun with the first point of east. Likewise for the bifilar magnetometer we have

$$\Delta b = \frac{k\,l\,R}{\tau\,r^2}\sin x\,\cos y,$$

y being the angle between the sun and the fourth point of the horizon; that is, the angle between the sun's radius vector and the axis $o\,y$. Finally, for the vertical-force magnetometer, in the prime vertical

$$\Delta_0 = \frac{k\,l\,R}{r^2}\sin x\,\sin y\,\sin h',$$

the angle h' being given from the equation $\tan h' = \cot b\,\sin a$. These formulæ give for the declinometer a periodical variation,

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which is double during a day everywhere. But for the bifilar magnetometer they show that on two occasions its period, which is generally also a double, is reduced to a simple one, viz., when $L = o$ and $\delta = o$. The vertical-force magnetometer, also, has a simple period at the equator complementary to the bifilar, as appears clearly from the value of

$$P = \sqrt{X^2 + Z^2}$$

which for $L = o$ is reduced to

$$P = \frac{k R l}{r^2} \sin \delta,$$

which multiplied by sin h', gives a simple period. In any other place the period is always double. These conclusions agree with the Observations, and explain the march of the components of horizontal and vertical force at St. Helena; and they exhibit the simple period of the bifilar magnetometer at the equinoxes, which is sufficiently well proved from the observations. These formulæ give for the day and night equal excursions, because they make abstraction of the influence of the interposition of the terrestrial globe during the night-time. This being magnetical, diminishes strongly the solar influence. Hence, the night excursions exist, but exceedingly much diminished in extent. We can apply the same formulæ to this case also, if we suppose the distance of the needle much increased, so that the night-range should become $\frac{1}{6}$ or $\frac{1}{7}$ of the day-range, as is manifest from the figures given by Sabine, *Hob. Observ.* (vol. i. p. 48, plate.) This also may explain some irregularities in the day-period; since a period begun, when the earth is not interposed (the needle not being yet in the shadow), will be partly destroyed by the supervening discontinuity of action. This, practically, must be very often the case, since the co-ordinate axes, which have been supposed to be directed according to the fundamental points of the astronomical horizon, must be rather directed towards the cardinal points which refer to the magnetic axis of the earth, and then w must be considered and computed from the sun's passage at the magnetic meridian. Our formulæ may explain also the singular fact of irregular perturbations of the needle happening at certain fixed hours. This phenomenon, although supposed to be connected with meteorological causes, is evidently also in connexion with solar periods, so that the maxima of perturbation arrive at the hours of maxima and minima of nocturnal periods. This is the case with the nine o'clock perturbations. To explain all the phenomena of diurnal variation is certainly an attempt superior to the state of our actual knowledge of magnetism, since this explanation depends upon the law of distribution of magnetism on the earth and the sun, and upon the law of magnetical induction, both which are completely unknown to us; what I have exposed here is only to try if, by means of the known laws of nature, we can thrown any light on this difficult subject. It is obvious that I do not mean to exclude

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variations of magnetism due to meteorological influences and auroras, or to any other cause of irregular perturbation, since I have taken into consideration only the effects of the sun, and even neglected some small parts and coefficients, which may become sensible perhaps in individual cases, and explain minor periods.

"*Roman College Observatory,*
"*Rome, Sept.* 9, 1854."

On Saturn's Rings. By J. R. Hind, Esq.

"In the *Monthly Notice* of this Society for June 1853, is given an extract from a letter of Sig. Secchi's, addressed to Capt. Manners, R.N., referring to a drawing of *Saturn's* ring, executed by Campani at Rome in 1664, and considered to afford confirmatory evidence of that remarkable conclusion deduced by M. Otto Struve,—that the ring is contracting upon the ball at a rate which at no distant period may bring it into contact with the globe.

"I have not seen it noticed anywhere in print, that the first volume of Lubienietski's *Theatrum Cometicum* contains a well-engraved sketch of the appearance of *Saturn* and his ring, no doubt founded upon the drawing, the original of which was forwarded by Signor Secchi to Capt. Manners.* It accompanied a letter from Father Athanasius Kirch to Lubienietski, dated Rome, 1665, July 25, and is thus alluded to in that communication,—'*Mitto hisce inclusum Systema Saturninum à Campano ingeniosissimo Telescoplopœo* 50 *palmorum tubo observatum.*' It appears to have been taken at the end of July 1664, when the ring was very open. On measuring the relative breadths of the ring and the dark space between the interior edge and the ball, the latter is seen to be very slightly the broadest. Reducing the dimensions to seconds of arc with M. Otto Struve's value for the equatoreal diameter of the globe, I find for the breadth of the rings 5″·58 and of the dark space 5″·77. These numbers agree very well with the relative breadth inferred from a remark of Huyghens, in his *Systema Saturnium,* applicable to the year 1657,—that the breadth of the interval between the interior border of the ring and the body of the planet was equal to, or perhaps rather exceeded, the breadth of the ring. M. Otto Struve argues that this observation of Huyghens, when taken in comparison with recent measures, is alone sufficient to prove that a very considerable change has occurred in the system of the rings since the middle of the seventeenth century: Campani's drawing is certainly rather favourable than otherwise to this view.

"The roughly executed diagram of *Saturn* and his ring, at the time of the greatest inclination of its plane to our line of vision in July 1667, found in Lemonnier's *Histoire Céleste,*—

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* See *Monthly Notice* for June 1853.